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Biology 30

Grade 12 Diploma Examination

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Biology 30

Grade 12 Diploma Examination

Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 48 multiple-choice and 8 numerical-response questions, of equal value, worth 70% of the examination
- 2 written-response questions, of equal value, worth 30% of the examination
- 80 total possible marks, worth 100% of the examination

This examination contains sets of related questions.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

Tear-out data pages are included near the back of this booklet.

The blank perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

- A. biology
- B. physics
- C. chemistry
- D. science

Answer Sheet

● (B) (C) (D)

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.

(Round and record your answer to three significant digits in the numerical-response section of the answer sheet.)

$$\begin{aligned}\text{Average} &= (21.0 + 25.5 + 24.5)/3 \\ &= 23.666 \\ &= 23.7\end{aligned}$$

Record 23.7 on the answer sheet →

2	3	.	7
---	---	---	---

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Correct-Order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____.
(Record all four digits in the numerical-response section of the answer sheet.)

- 1 physics
- 2 chemistry
- 3 biology
- 4 science

Answer 3214

**Record 3214 on the
answer sheet** →

3	2	1	4
---	---	---	---

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Selection Question and Solution

The birds in the following list are numbered _____.

(Record your answer in lowest-to-highest numerical order in the numerical-response section of the answer sheet.)

- 1 dog
- 2 sparrow
- 3 cat
- 4 robin
- 5 chicken

Answer 245

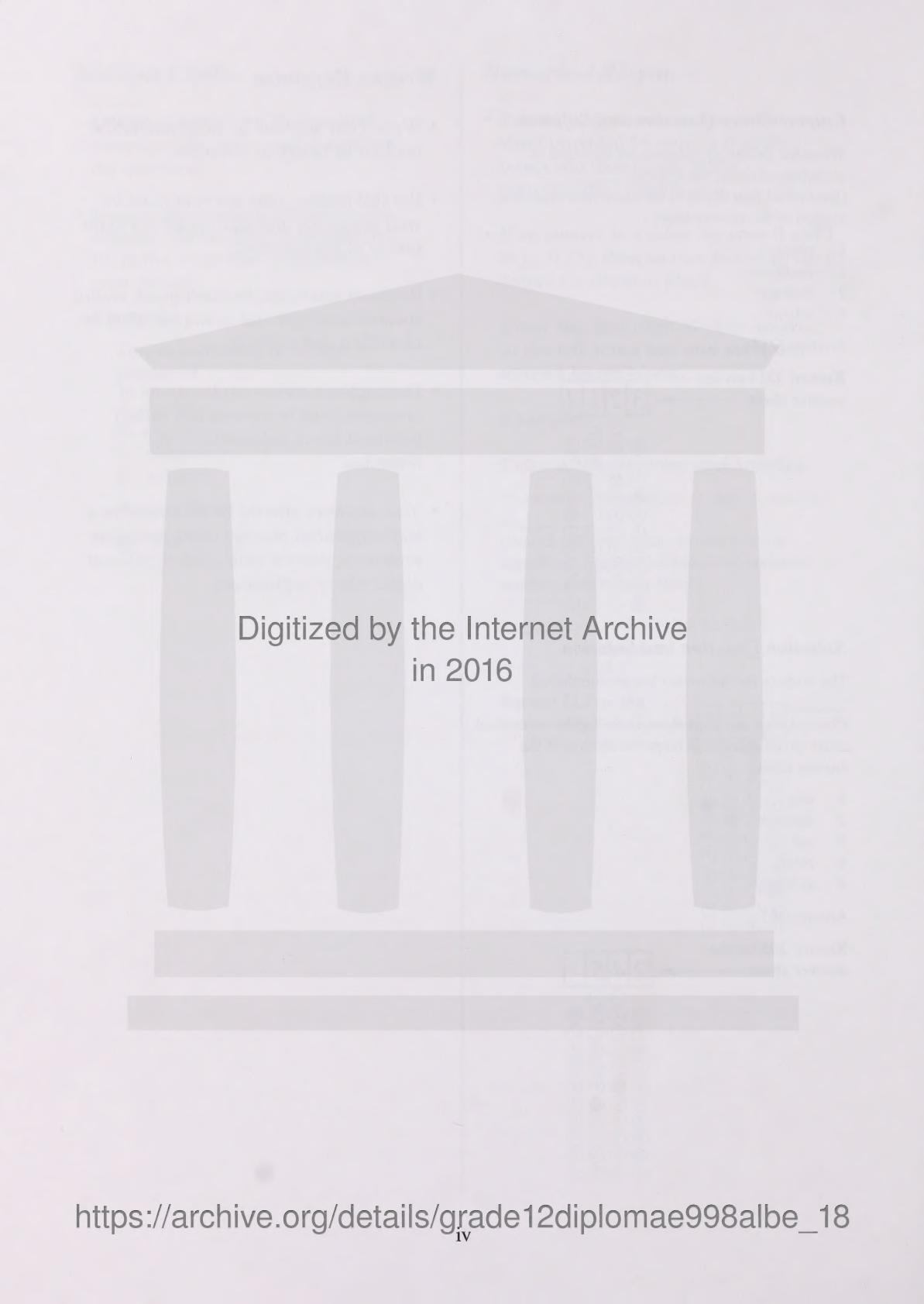
**Record 245 on the
answer sheet** →

2	4	5	
---	---	---	--

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and explicit.
- Descriptions and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.



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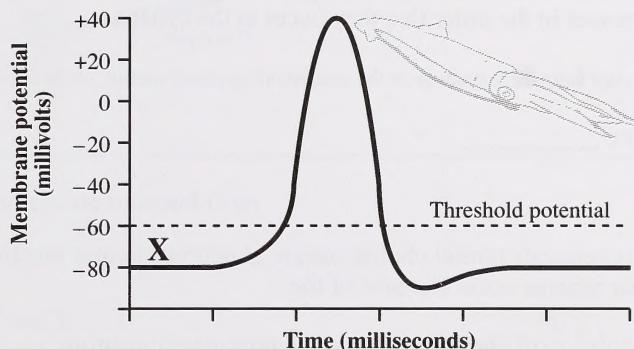
While animals interact with their external environment, their nervous and endocrine systems maintain internal equilibrium. The study of organisms and of disease processes has helped extend our knowledge of these systems.

Use the following information to answer the next two questions.

"The [study of the squid, led] to an understanding of the nature of the nerve impulse. [Its] . . . nerves contain the giant axons used in all the early studies of the nerve impulse."

—from *Curtis and Barnes*

An Action Potential



Note: X denotes the electrical potential across the membrane of a particular resting neuron.

1. Which of the following statements is **true** of the threshold potential?
 - A. It is the same electrical potential for all neurons.
 - B. It is the depolarization required to generate an action potential.
 - C. It determines the time it takes for an action potential to be completed.
 - D. It determines the time it takes for an impulse to travel along the axon.
2. Relative to inside of a neuron, the extracellular fluid immediately outside a resting neuron's cell membrane is
 - A. positive and the sodium ion concentration is less
 - B. negative and the sodium ion concentration is less
 - C. positive and the sodium ion concentration is greater
 - D. negative and the sodium ion concentration is greater

Use the following information to answer the next two questions.

**Processes That Occur at a Neuromuscular Junction
(A Type of Synapse)**

- 1 Muscle fibres contract when sodium gates open allowing sodium ions to diffuse into the muscle cytoplasm.
- 2 Acetylcholine is released from the axon terminal.
- 3 Acetylcholine binds to the receptors on the muscle cell.
- 4 Cholinesterase breaks down acetylcholine, and the sodium gates close.

—from *Guyton*

Numerical Response

1. An impulse arrives at an axon terminal that synapses with a muscle cell. Record the processes in the order that they occur at the synapse.

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: _____

3. Certain chemicals inhibit cholinesterase at neuromuscular junctions. The resulting muscular spasms occur because of the

- A. depletion of cholinesterase in the presynaptic neuron
- B. depletion of acetylcholine in the neuromuscular junction
- C. accumulation of cholinesterase in the presynaptic neuron
- D. accumulation of acetylcholine in the neuromuscular junction

Use the following information to answer the next question.

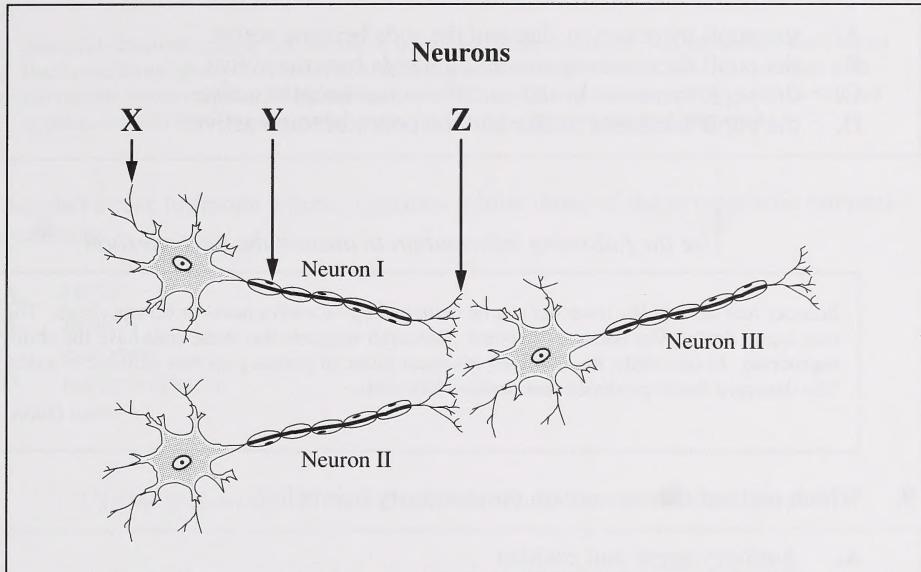
Twenty-two once-paralyzed rats can now move their hind legs and even take awkward steps. Their damaged spinal cords have been partially repaired by surgically grafting nerve fibres from another part of their bodies to the damaged area.

—from *Flam*

4. The division of the nervous system that was damaged in these rats is the

- A. central nervous system
- B. somatic nervous system
- C. sympathetic nervous system
- D. parasympathetic nervous system

Use the following information to answer the next three questions.



5. Neurotransmitters are released from

- A. site X
- B. site Z
- C. sites X and Y
- D. sites X and Z

6. If neurons I and II are interneurons, neuron III **cannot** be a

- A. parasympathetic neuron
- B. sympathetic neuron
- C. sensory neuron
- D. motor neuron

7. In a typical reflex arc, neuron III would be part of the

- A. effector
- B. receptor
- C. motor pathway
- D. sensory pathway

8. When adaptation of the eye occurs to view objects in a dark room,

- A. the pupil increases in size and the rods become active
- B. the pupil decreases in size and the rods become active
- C. the pupil increases in size and the cones become active
- D. the pupil decreases in size and the cones become active

Use the following information to answer the next question.

Sensory hair cells in the inner ear can be damaged by excessive noise or certain drugs. This may cause deafness or balance disorders. Research suggests that these cells have the ability to regenerate. In one study, the damaged inner ear tissue of guinea pigs was cultured in a dish. The damaged tissue produced new sensory hair cells.

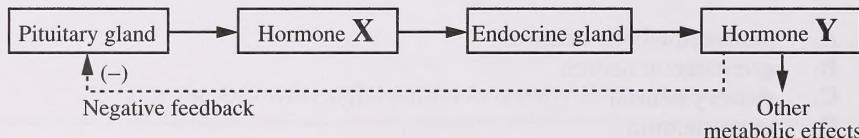
—from *Gutin*

9. Which parts of the ear contain these sensory hair cells?

- A. Auditory nerve and cochlea
- B. Eardrum and auditory nerve
- C. Eustachian tube and eardrum
- D. Cochlea and semicircular canals

Use the following information to answer the next question.

Control of the Secretion of Hormone Y by the Pituitary Gland



10. Normally, inhibition of the pituitary gland would occur if the secretion of hormone X

- A. increased, causing a decrease in the secretion of hormone Y
- B. decreased, causing a decrease in the secretion of hormone Y
- C. increased, causing an increase in the secretion of hormone Y
- D. decreased, causing an increase in the secretion of hormone Y

Use the following information to answer the next two questions.

Stressful situations trigger the release of hormones such as cortisol. Recent studies have found that some forms of depression cause a similar hormonal response that lasts much longer than the normal stress response. This unregulated release of stress hormones may result in reduced appetite, an unresponsive immune system, inadequate tissue repair, and insomnia.

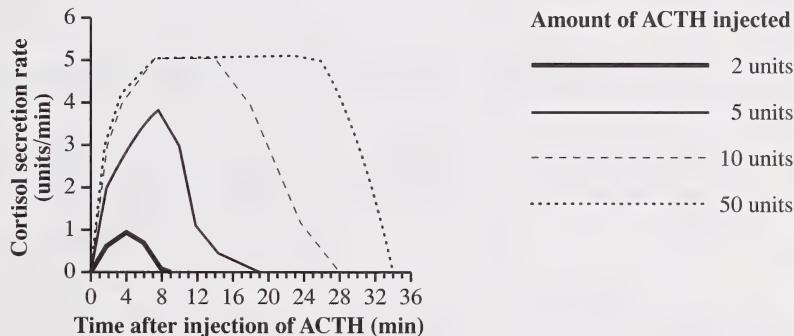
11. Another stress hormone whose functions mimic those of the sympathetic nervous system is

- A. HCG
- B. insulin
- C. estrogen
- D. norepinephrine

Use the following additional information to answer the next question.

A dog with a malfunctioning pituitary gland received injections of ACTH. Data were collected after the dog's injections.

Rate of Cortisol Secretion After the Injection of Varying Amounts of ACTH



—from *Ganong*

12. A logical interpretation of the graph is that the

- A. secretion of cortisol is inhibited by increased ACTH
- B. secretion of cortisol is doubled if the secretion of ACTH is doubled
- C. adrenal glands respond more quickly to small amounts of ACTH than to large amounts of ACTH
- D. adrenal glands respond to large amounts of ACTH by having a maximum cortisol secretion rate

Use the following information to answer the next question.

In 1947, E. B. Verney published the results of a series of experiments that he had conducted on a number of dogs. He found that if he injected a concentrated salt solution into the bloodstream, hypothalamus, and ventricles of the brain, hormone "X" was released in large amounts.

13. Hormone "X" was most likely

- A. ADH
- B. ACTH
- C. oxytocin
- D. aldosterone

14. The endocrine function of the pancreas was studied in Canada using dogs as experimental animals. The pancreatic cells with an endocrine function are

- A. islet cells
- B. blood cells
- C. Sertoli cells
- D. interstitial cells

Use the following information to answer the next two questions.

Bovine somatotropin (BST) is a growth hormone that has been produced using biotechnology since 1970. BST increases milk production by 10% to 20% when injected into milk-producing cows. BST increases nutrient absorption from the bloodstream into the cow's mammary gland.

—from Harpp and Joseph

15. BST could probably be obtained naturally from which gland in a cow?

- A. Thyroid
- B. Adrenal
- C. Pituitary
- D. Pancreatic

16. In a cow's mammary gland, BST is most similar in its effect to

- A. estrogen
- B. oxytocin
- C. prolactin
- D. progesterone

17. In humans, when iodine levels are adequate, abnormally high TSH secretion would likely result in

- A. nervousness and weight gain
- B. nervousness and weight loss
- C. sleepiness and weight gain
- D. sleepiness and weight loss

Use the following information to answer the next question.

Several studies have indicated that sperm counts in humans have declined over the past 25 years. Increased levels of chemicals in the environment that mimic estrogen have been found in substances ranging from detergents to plastic wrappers. These chemicals are a suspected cause of the decline in sperm counts.

—from *Stainsby*

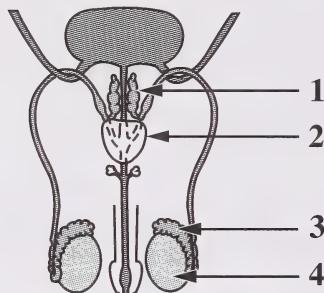
18. Males exposed to high levels of these estrogen-mimicking chemicals could experience

- A. development of breasts
- B. development of ovaries
- C. increased growth of muscles
- D. increased growth of facial hair

Reproductive processes may be affected by disease, the environment, or the use of technology.

Use the following information to answer the next question.

Male Reproductive System



19. The structure that may function both as a site for spermatogenesis and as an endocrine gland is labelled

- A. 1
- B. 2
- C. 3
- D. 4

Use the following information to answer the next question.

An unusual and rare form of the disease cystic fibrosis results in the absence of the vas deferens in males.

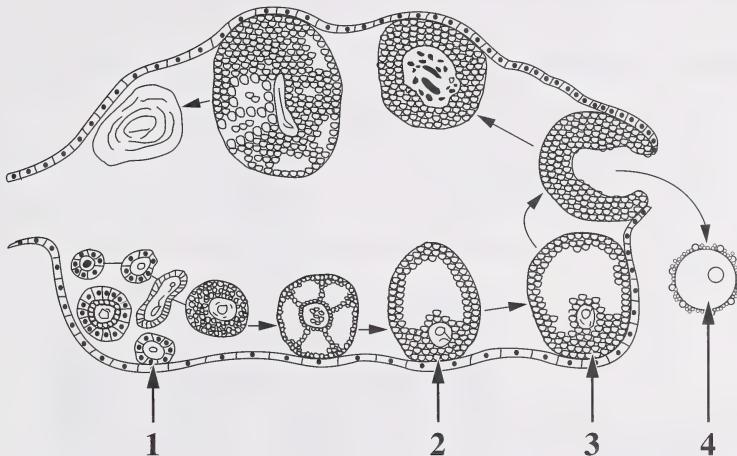
—from *Henahan*

20. When this occurs, infertility results because of

- A. decreased spermatogenesis
- B. an inability to maintain an erection
- C. decreased secretions of alkaline buffers
- D. the failure of sperm to reach the urethra

Use the following information to answer the next two questions.

Composite Diagram of a Human Ovary



This diagram shows the sequence of events in the development of a follicle in one reproductive cycle of a non-pregnant female.

21. The part of the diagram that represents the follicle just before day 14 of an average ovarian cycle is labelled

- A. 1
- B. 2
- C. 3
- D. 4

22. Which description identifies the chromosome content of cell 4?

- A. $n = 23$
- B. $n = 46$
- C. $2n = 23$
- D. $2n = 46$

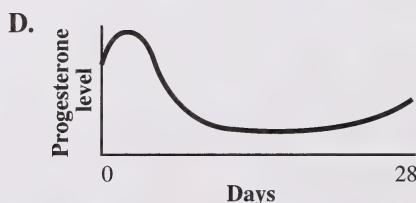
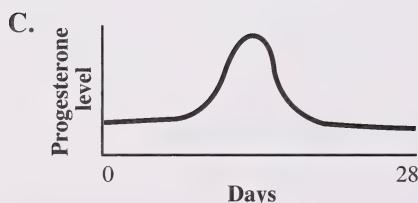
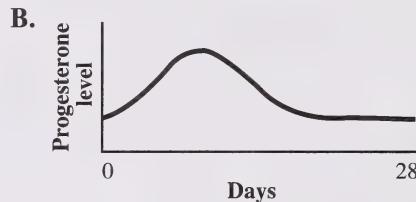
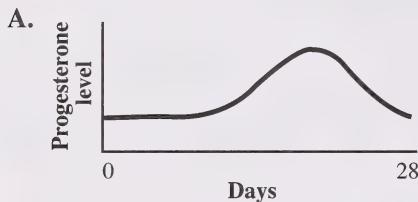
Use the following information to answer the next question.

Microscopic examination has revealed protective layers surrounding the oocyte. The first sperm to reach the oocyte is usually not the one to fertilize it.

23. The reason this first sperm may not fertilize the oocyte is that

- A. its nucleus may not be acceptable for fertilization
- B. some sperm produce enzymes that fail to break down the protective layers
- C. the enzymes from many sperm are needed to penetrate the protective layers
- D. the protective layers secrete chemicals that destroy many sperm that contact the oocyte

24. A graph that illustrates the cyclical variation in progesterone levels in one reproductive cycle of a non-pregnant human female is

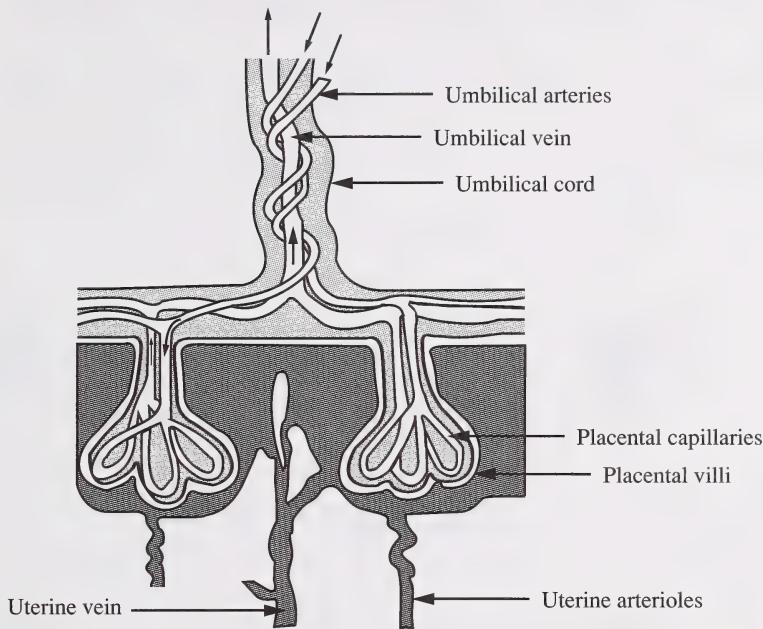


25. It has been observed that some breastfeeding mothers do not ovulate until they stop breast feeding. Ovulation **would not** occur if

- A. prolactin inhibits the release of oxytocin
- B. prolactin inhibits follicular development
- C. oxytocin stimulates the release of FSH and LH
- D. oxytocin stimulates the release of gonadotropin-releasing hormone

Use the following information to answer the next question.

A Schematic View of the Placenta



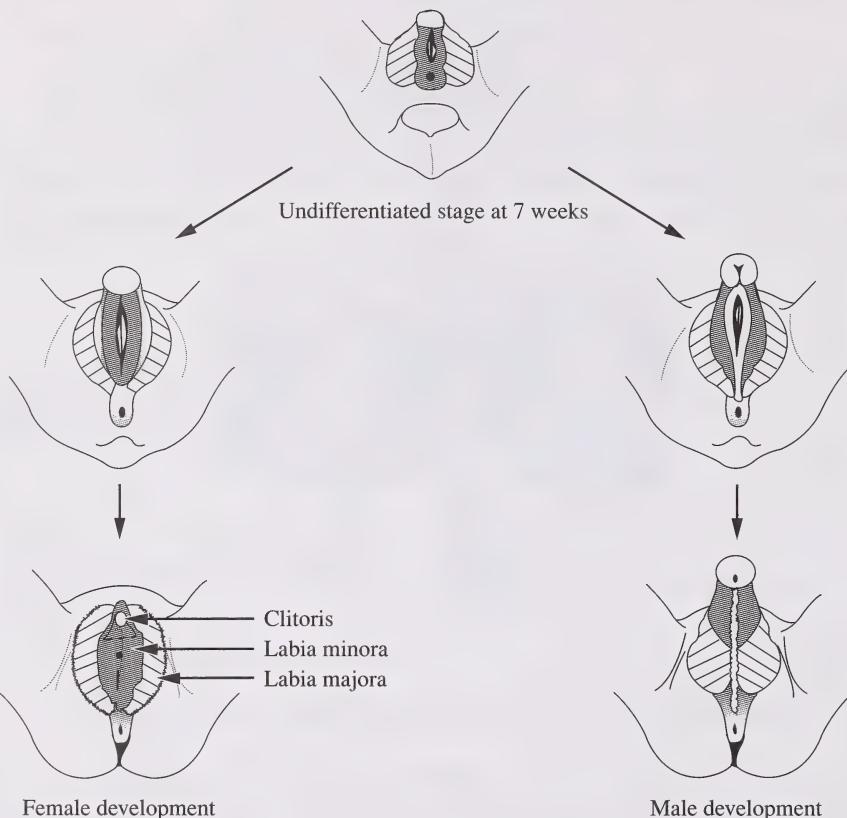
—from *Curtis*

26. Which of the following does **not** normally occur at the placenta?

- A. Nutrients move from the maternal blood to the fetal blood
- B. Blood cells move from the maternal blood to the fetal blood
- C. Carbon dioxide moves from the fetal blood to the maternal blood
- D. Metabolic wastes move from the fetal blood to the maternal blood

Use the following information to answer the next two questions.

Development of external genital structures of both sexes from the same undifferentiated embryonic structures



—from *Campbell*

27. Study the diagram. In the table below, the row that identifies two pairs of male and female external genital structures where each pair develops from the same embryonic structure is

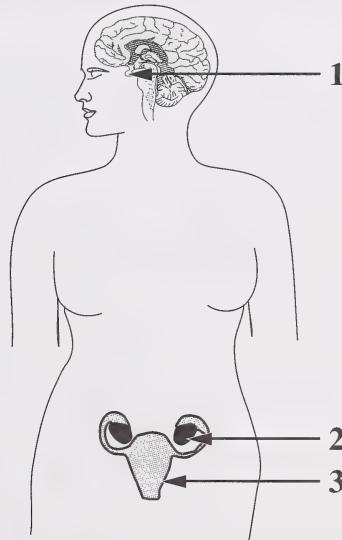
	Come from Same Embryonic Structure		Come from Same Embryonic Structure	
	Male	Female	Male	Female
A.	penis-shaft	clitoris	scrotum	vagina
B.	penis-shaft	labia majora	scrotum	labia minora
C.	penis-glands	clitoris	scrotum	labia majora
D.	penis-glands	labia majora	scrotum	labia minora

28. Under normal circumstances, what **initially** determines whether an embryo develops into a male or a female?

- A. The embryo develops testes for a male and ovaries for a female.
- B. The embryo predominantly produces testosterone for a male and estrogen for a female.
- C. The embryo's genital embryonic structures develop into those of a male or those of a female.
- D. The embryo develops into a male if fertilization involved a Y-carrying sperm and into a female if fertilization involved an X-carrying sperm.

Use the following information to answer the next question.

Some Structures of the Human Female



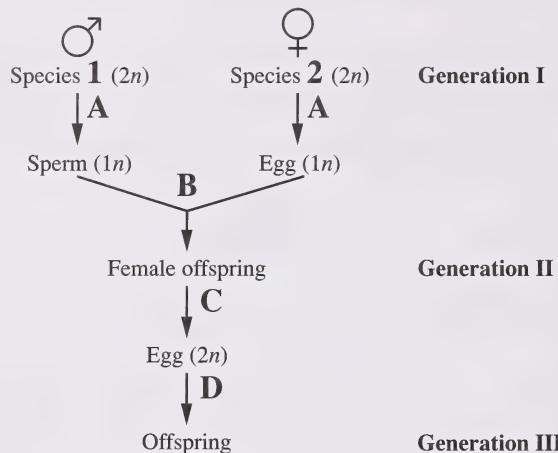
29. The gland that releases oxytocin and the target organ for oxytocin are labelled, respectively,

- A. 1 and 2
- B. 1 and 3
- C. 2 and 1
- D. 2 and 3

The study of cell division, chromosome composition, and the structure and function of DNA increases understanding of growth, heredity, and diversity of organisms.

Use the following information to answer the next three questions.

Males and females of different lizard species can interbreed, but often the offspring of these matings are sterile. However, some of the female offspring, as adults, produce diploid eggs that develop without fertilization. The offspring of these “virgin births” all reproduce in the same way as their mother.



—from Richardson

30. Phenotypically, generation III offspring will be

- A. female, and each individual will be genotypically different
- B. female, and each individual will be genotypically identical
- C. 50% male and 50% female, and will be genotypically different
- D. 50% male and 50% female, and will be genotypically identical

31. If a new disease-causing organism from which lizards have **no** protection reaches an island where a uniform population of lizards reproduce **only** asexually, a likely outcome is that

- A. rapid extinction of the lizard population will occur
- B. the lizard population will begin to reproduce sexually
- C. gene frequencies will change in the lizard population's gene pool
- D. unique individuals in the lizard population will not find a mating partner

Numerical Response

2. From the list below, identify the processes that correspond to A, B, C, and D in the diagram on the previous page.

Normal Processes

- 1 Fertilization
- 2 Meiosis
- 3 Mitosis

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: Process

Use the following information to answer the next question.

Many adult newts and salamanders have a remarkable ability to regenerate amputated limbs. After amputation of a foot, a newt will regenerate the lost foot. However, if a newt has its foot amputated and receives a particular dosage of vitamin A, the animal grows back a whole new forelimb, not just the foot!

—from *Pietsch*

32. A logical interpretation that can be drawn from this information is that vitamin A may play a major role in growth by

- A. increasing the amount of mitosis
- B. increasing the amount of meiosis
- C. decreasing the amount of mitosis
- D. decreasing the amount of meiosis

Use the following information to answer the next three questions.

Nondisjunction in meiosis disrupts the chromosome number in the gametes that are produced. Nondisjunction can occur in either the first or second division of meiosis and results in various genetic disorders.

33. One homologous pair of chromosomes in a human spermatogonium undergoes nondisjunction during the first division of meiosis. After meiosis is completed, what number of chromosomes will the four newly produced cells contain?

A. All four cells will have 23 chromosomes.
B. Two cells will have 22 chromosomes, and two cells will have 24 chromosomes.
C. One cell will have 22 chromosomes, and three cells will have 24 chromosomes.
D. One cell will have 24 chromosomes, and three cells will have 22 chromosomes.

34. Which expression of chromosome content represents somatic cells in people with trisomy disorders such as Down syndrome?

A. $n - 1$
B. $n + 1$
C. $2n - 1$
D. $2n + 1$

Use the following additional information to answer the next question.

Polyploids are organisms with three or more complete sets of chromosomes. If a diploid organism is $2n$, then a triploid is $3n$, a tetraploid is $4n$, and so on.

All major groups of seed plants have some polyplloid members. Plant polyploids are larger than plants with $2n$ chromosome number. Plant polyploids with even chromosome numbers (e.g., $4n$) can usually produce pollen and seeds. Plant polyploids with odd chromosome numbers (e.g., $5n$) are nearly always sterile.

35. If a diploid plant and a tetraploid plant, each capable of normal meiosis, were crossed, the chromosome number in their offspring would be

A. $2n$
B. $3n$
C. $4n$
D. $6n$

Use the following information to answer the next question.

A Cellular Structure Found During Mitosis



36. This diagram of a cellular structure shows

- A. one crossed-over pair of chromosomes
- B. two homologous chromosomes
- C. one tetrad of chromatids
- D. two sister chromatids

Use the following information to answer the next question.

The San Diego Zoo is preserving DNA from hundreds of species by freezing cell samples in its Centre for the Reproduction of Endangered Species. The cell specimens are often from individuals in wild populations that are chosen for distinctive characteristics.

—from *Vedantam*

37. To obtain all the representative DNA of an organism, it would be necessary to collect **only**

- A. an egg
- B. a sperm
- C. a body cell
- D. a cell from each type of body tissue

Numerical Response

3. Of the nitrogen-based molecules present in the DNA of sea urchins, 17.5% are cytosine molecules. Calculate the **percentage** composition of thymine in sea urchin DNA.

(Record your **answer as a percentage rounded to one decimal place** in the numerical-response section of the answer sheet.)

Answer: _____ %

Use the following information to answer the next three questions.

Gregor Mendel examined the inheritance of two traits in pea plants: seed coat texture and colour. Seed coat texture can be represented as S —smooth and s —wrinkled, and seed coat colour can be represented as Y —yellow and y —green. $SSYY$ plants were crossed with $ssyy$ plants to yield F_1 pea seeds that were all smooth and all yellow. By crossing plants grown from these F_1 seeds, Mendel obtained four different phenotypes of F_2 seeds:

- smooth and green seeds
- wrinkled and green seeds
- smooth and yellow seeds
- wrinkled and yellow seeds

38. If the traits for seed coat texture and seed coat colour had been located close together on the same chromosome, Mendel might **not** have conceptualized

- gene pairs
- dominance
- the Law of Segregation
- the Law of Independent Assortment

Numerical Response

4. The F_2 seed phenotype ratio that Mendel obtained upon crossing two heterozygous smooth and yellow F_1 individuals would have been _____.

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: _____ : _____ : _____ : _____
smooth and wrinkled and smooth and wrinkled and
green green yellow yellow

Use the following additional information to answer the next question.

Mendel selected two varieties of pea plants from seeds he had grown. One variety of peas came from a field planted with smooth, yellow seeds. Another variety of peas came from a field planted with wrinkled, green seeds. These two varieties of peas were crossed to produce

- 255 plants with smooth and green seeds
- 268 plants with wrinkled and green seeds
- 237 plants with smooth and yellow seeds
- 240 plants with wrinkled and yellow seeds

From the phenotype ratio of the offspring, Mendel deduced that the smooth and yellow parents had the genotype $YySs$.

39. This type of cross is referred to as a

- A. test cross
- B. monohybrid cross
- C. homozygous cross
- D. heterozygous cross

Use the following information to answer the next two questions.

In Labrador retriever dogs, two alleles, B and b , determine whether the coat colour will be black (B) or brown (b). Black coat colour is dominant. A second pair of alleles, E and e , are on a separate chromosome from B and b . The homozygous recessive condition, ee , prevents the expression of either allele B or b and produces a dog with a yellow-coloured coat. Some examples of genotypes and phenotypes for Labrador retrievers are shown below.

Genotype	Phenotype
$BBEe$	black
$bbEe$	brown
$Bbee$	yellow

—from Davol

40. What is the probability of obtaining a black puppy from the following cross?

$$BbEe \times BbEE$$

- A. $\frac{9}{16}$
- B. $\frac{3}{16}$
- C. $\frac{3}{4}$
- D. $\frac{1}{4}$

Numerical Response

5. Two dogs, each with the genotype $BbEe$, were crossed. What is the **percentage** probability that their offspring would have yellow coat colour?

(Record your answer as a **whole number percentage** in the numerical-response section of the answer sheet.)

Answer: _____

Use the following information to answer the next question.

A recessive allele causes *Drosophila* to have white eyes instead of wild-type eyes. This eye colour gene is known to be X-linked. In a cross between homozygous wild-type females and white-eyed males, all F_1 progeny have wild-type eyes.

41. What ratio of wild-type to white-eyed progeny can be expected in each sex if F_1 females are crossed to males of the same genotype as their father?

- A. Males – 1:0, females – 1:0
- B. Males – 1:1, females – 1:0
- C. Males – 0:1, females – 1:1
- D. Males – 1:1, females – 1:1

Use the following information to answer the next question.

Crossover Frequencies for Some Genes on *Drosophila* Chromosome One

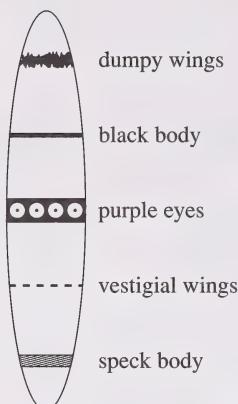
Genes	Crossover Frequency
White eyes (<i>w</i>) and Facet eyes (<i>f</i>)	1.5%
White eyes (<i>w</i>) and Echinus eyes (<i>e</i>)	4.0%
White eyes (<i>w</i>) and Ruby eyes (<i>r</i>)	6.0%
Facet eyes (<i>f</i>) and Echinus eyes (<i>e</i>)	2.5%
Facet eyes (<i>f</i>) and Ruby eyes (<i>r</i>)	4.5%

42. The crossover frequency between genes *e* and *r* is

- A. 3.5%
- B. 2.0%
- C. 1.5%
- D. 0.5%

Use the following information to answer the next two questions.

Locations of Some Genes on a Section of a *Drosophila* Chromosome



43. During meiosis, which pair of genes have the **best** chance of being transferred **together** to a new cell?

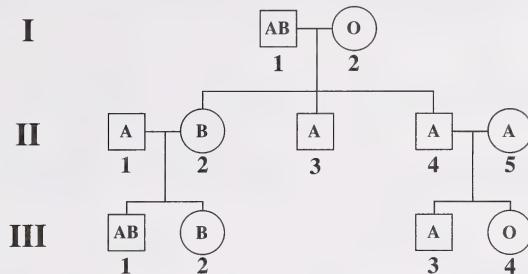
- A. Black body and purple eyes
- B. Purple eyes and speck body
- C. Dumpy wings and purple eyes
- D. Dumpy wings and speck body

44. To determine whether this is an X chromosome or an autosome, a researcher would have to determine whether these traits are

- A. recessive
- B. dominant
- C. passed from male parents to their male offspring
- D. passed from female parents to their male offspring

Use the following information to answer the next two questions.

A Pedigree Showing the Incidence of ABO Blood Types in a Family



45. Which individual is a known homozygote for blood type?

- A. I-1
- B. I-2
- C. II-2
- D. II-3

46. Which of the following rows correctly identifies the genotypes of individuals III-2 and III-3?

Row	Individual III-2	Individual III-3
A.	$I^B i$ or $I^B I^B$	$I^A i$
B.	$I^B i$	$I^A i$ or $I^A I^A$
C.	$I^B i$ or $I^B I^B$	$I^A i$ or $I^A I^A$
D.	$I^B i$	$I^A i$

Communities are made of populations and may reach equilibrium or change over time.

Use the following information to answer the next two questions.

In sheep, white wool is a dominant trait and black wool is a recessive trait. In a herd of 500 sheep, 20 sheep have black wool.

Numerical Response

6. In this herd, what is the frequency of the heterozygous genotype?

(Record your answer as a value from 0 to 1, rounded to two decimal places, in the numerical-response section of the answer sheet.)

Answer: _____

Numerical Response

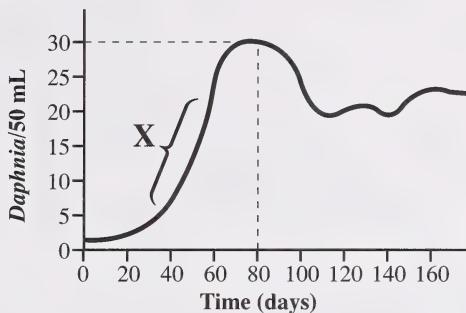
7. If two heterozygous sheep mated, what would be the probability of them having a white lamb?

(Record your answer as a value from 0 to 1, rounded to two decimal places, in the numerical-response section of the answer sheet.)

Answer: _____

Use the following information to answer the next two questions.

The Changes in a *Daphnia* Population Over Time



The graph represents a population of *Daphnia* (water fleas) cultured in a stable nutritional environment.

—from *Campbell*

47. The region labelled X on the graph represents

- A. exponential growth
- B. the carrying capacity
- C. the establishment phase
- D. environmental resistance

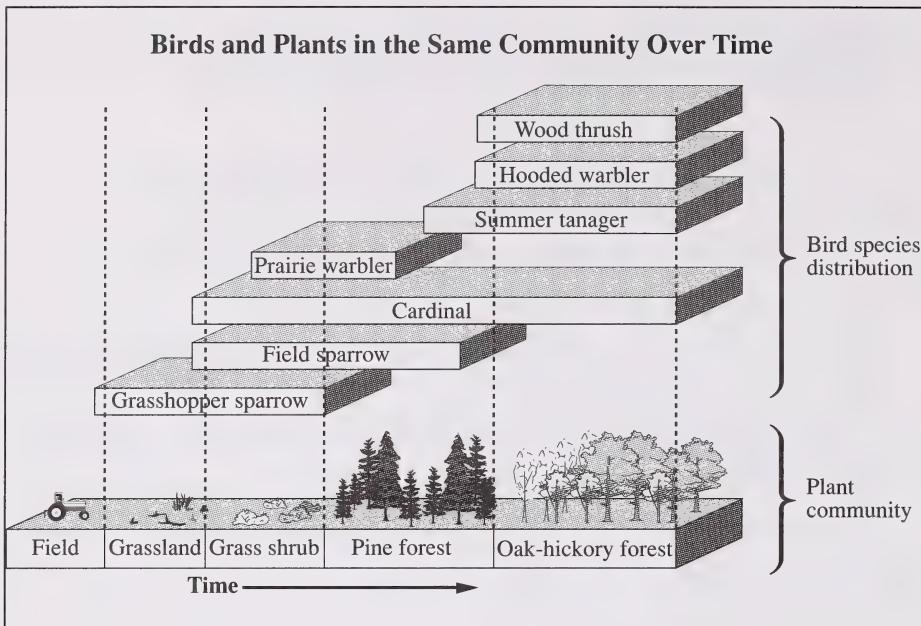
Numerical Response

8. The density of *Daphnia* on day 80 is _____/mL.

(Record your answer rounded to two decimal places in the numerical-response section of the answer sheet.)

Answer: _____

Use the following information to answer the next question.



48. The process depicted by the above diagram illustrates

- A. primary succession
- B. random genetic drift
- C. secondary succession
- D. Hardy-Weinberg equilibrium

Use the following information to answer the next question.

Biomimetics is a new area of study wherein biologists, chemists, physicists, and engineers exchange ideas in an attempt to understand what gives natural materials their properties and how these might be applied.

Zoologist John Gosline at the University of British Columbia has investigated spider dragline silk. This is the silk that a spider hangs from and uses to build the frame portion of its web. Spider silk can be as strong per unit weight as high-tensile steel; it can stretch more than nylon; and it is tougher than the Kevlar used in bulletproof vests. It is hoped that synthetic spider silk can be produced and used to manufacture wear-resistant clothing, rust-free automobile panels and bumpers, artificial tendons and ligaments, and suspension-bridge cables.

Dragline silk of the golden orb-weaving spider, *Nephila clavipes*, has been shown to include seven main amino acids as its primary constituents. Large amounts of glycine and alanine are present, as well as lesser amounts of glutamine, leucine, arginine, tyrosine, and serine.

Lynn Jelinski, a biophysicist at Cornell University, proposed a model to explain dragline silk's strength and elasticity. She and her colleagues have shown how components of natural silk hang together. Each fibre consists of two alanine-rich crystalline proteins embedded in a glycine-rich protein polymer. According to their model, the protein polymer makes the fibre elastic and the two types of crystalline protein give it toughness.

—from *Hamilton; Lipkin; Simmons, Michal, and Jelinski*

Written Response – 12 marks

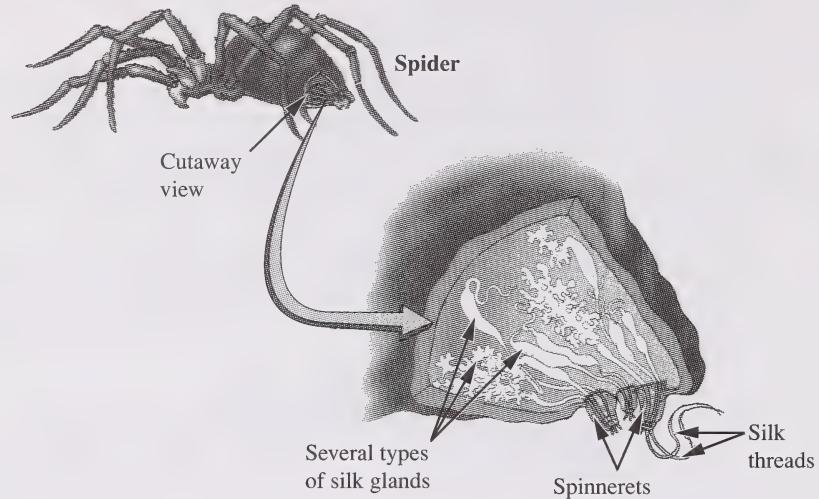
1. a. Determine whether the following portion of a coding DNA sequence would provide dragline silk with toughness or with elasticity. Show your work and explain your reasoning.

(3 marks)

DNA CCTGCTCCCCGAGACCA

Use the following information to answer the next question.

Different cells in the spider are in different stages of the cell cycle.



—from Wallace, Sanders, and Ferl

(3 marks)

b. i. Identify the main activities in each of the three stages of the cell cycle.

(1 mark)

ii. Spiders produce silk in cells within silk glands located in the abdomen. In which stage of the cell cycle would cells produce silk?

Use the following additional information to answer the next part of the question.

In 1990, University of Wyoming biochemist Randy Lewis identified a gene linked to the production of proteins in spider silk. This was the first step in allowing bioengineers to insert copies of the gene into bacteria, in hope of turning the bacteria into microscopic spider silk protein factories.

c. Describe the process of **inserting** the silk protein gene into bacterial DNA.

(2 marks)

Use the following additional information to answer the next part of the question.

Gosline and Jelinski's field of study is often referred to as biomimicry. Other scientists in biomimicry have investigated the design of a walnut shell in order to build a better crash helmet and the composition of horses' hooves in order to design stress-resistant building materials.

d. Define mimicry as it is usually used in biology, and explain why biomimicry is or is not an appropriate name for this new area of research.

(3 marks)

Use the following information to answer the next question.

The estimated North American population of grey wolves is around 67 000 and is found mostly in Canada and Alaska. In early 1995, grey wolves were reintroduced into Yellowstone National Park (about 400 km south of Alberta) where they had previously been completely exterminated.

Wolves are large social carnivores that hunt in packs and usually feed on elk or sometimes deer. They kill mostly young and old animals, a practice that removes those elk least likely to survive harsh winters. Wolves normally breed once a year, but when prey is scarce and/or pack sizes are large, many females may not become fertile. Litter sizes vary from three to six pups, depending on available food. Studies of wolves in the central Canadian Rockies reveal that unequal numbers of males and females exist and that dominant (alpha) males mate only with (alpha) females.

The reintroduction of grey wolves to Yellowstone has affected the entire Yellowstone Basin Ecosystem. Field biologists report that elk are huddling in large groups for protection and that grizzlies are fighting wolves. Coyotes are about half the size of wolves, and each coyote pack has a smaller territory. They are sometimes killed by wolves when the two species fight over elk carcasses. Wolves disturb coyote den sites and sometimes kill and eat the young. The wolves have killed about 36 coyotes since their introduction. Biologists maintain that wolves have returned the ecosystem to a more natural state. The wolf population has grown from the 31 wolves that were reintroduced to 53.

Wildlife enthusiasts have thronged to Yellowstone to watch wolf packs from roadsides, but the strong dispersal capability of wolves means that wolves and landowners often have encounters outside the park. Ranchers and farmers had resisted the reintroduction of wolves to Yellowstone and had predicted that hundreds of livestock would be killed. Wolves that prey on livestock are usually shot.

Nuclear DNA analysis of several North American wolf populations has revealed ample genetic diversity among the populations studied. Genetic variation is a concern, however, in an isolated wolf population such as the one created by the program in the Yellowstone Basin Ecosystem or in isolated wolf populations formed in the United States by wolves that have travelled there from southern parts of Alberta.

—from Ferris; Noss, et al.; Sahagun

Written Response – 12 marks

2. Write a unified essay that addresses the following aspects of grey wolf populations in North America.

- **Identify and describe** the relationships that exist between wolves and elk, between coyotes and elk, and between wolves and coyotes. **Describe** how these relationships affect population sizes and the behaviours of wolves, elk, and coyotes in the Yellowstone Basin Ecosystem.
- **Classify and explain** the reproductive strategy exhibited by wolves. **Identify** two factors that may influence grey wolf population growth and **explain** how these factors would affect this growth.
- **Describe** two factors that might cause the genetic diversity of an isolated grey wolf population to decrease. **Explain** a reproductive technology that, when applied to wolves, could increase the north–south gene flow between Canadian wolf packs and colonizing wolf packs in United States.

Continued

Continued

*You have now completed the examination.
If you have time, you may wish to check your answers.*

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NR8

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BIOLOGY DATA

Symbols

Symbol	Description	Symbol	Description
D_p	population density	σ	male
N	numbers of individuals in a population	φ	female
A	area, space, or volume occupied by a population	n	chromosome number
t	time	B, b	alleles; upper case is dominant, lower case is recessive
Δ	change	I^A, I^B, i	alleles, human blood type (ABO)
r	biotic potential OR maximum per capita population growth rate	P	parent generation
K	carrying capacity	F_1, F_2	first, second filial (generation)
$\frac{\Delta N}{\Delta t}$	a change in population size during time interval	p	frequency of dominant allele
$>$	greater than, dominant over	q	frequency of recessive allele
$<$	less than, recessive to		

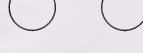
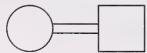
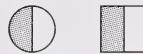
Equations

Subject	Equation
Hardy-Weinberg principle	$p^2 + 2pq + q^2 = 1$
Population density	$D_p = \frac{N}{A}$
Change in population size	$\Delta N = (\text{factors that increase pop.}) - (\text{factors that decrease pop.})$
Per capita growth rate (time will be determined by the question)	$cgr = \frac{\Delta N}{N}$
Growth rate	$\frac{\Delta N}{\Delta t} = rN$ $\frac{\Delta N}{\Delta t} = rN \frac{(K - N)}{K}$

Abbreviations for Some Hormones

Hormone	Abbreviation
Adrenocorticotropin hormone	ACTH
Antidiuretic hormone	ADH
Follicle stimulating hormone	FSH
Human chorionic gonadotropin	HCG
Luteinizing hormone	LH (formerly ICSH in males)
Parathyroid hormone	PTH
Prolactin	PRL
Somatotropin (human growth hormone or growth hormone)	STH (HGH or GH)
Thyroid stimulating hormone	TSH

Pedigree Symbols

	Male		Identical twins
	Female		Non-identical twins
	Mating		Affected individuals
	Mating between close relatives		Known heterozygotes for autosomal recessive
I 	Roman numerals symbolize generations		Known carrier of X-linked recessive
II 	Arabic numbers symbolize individuals within a given generation		Deceased individuals
	Birth order, within each group of offspring, is drawn left to right, oldest to youngest		Sex unknown

Messenger RNA Codons and Their Corresponding Amino Acids

First Base	Second Base				Third Base
	U	C	A	G	
U	UUU phenylalanine	UCU serine	UAU tyrosine	UGU cysteine	U
	UUC phenylalanine	UCC serine	UAC tyrosine	UGC cysteine	C
	UUA leucine	UCA serine	UAA stop **	UGA stop **	A
	UUG leucine	UCG serine	UAG stop **	UGG tryptophan	G
C	CUU leucine	CCU proline	CAU histidine	CGU arginine	U
	CUC leucine	CCC proline	CAC histidine	CGC arginine	C
	CUA leucine	CCA proline	CAA glutamine	CGA arginine	A
	CUG leucine	CCG proline	CAG glutamine	CGG arginine	G
A	AUU isoleucine	ACU threonine	AAU asparagine	AGU serine	U
	AUC isoleucine	ACC threonine	AAC asparagine	AGC serine	C
	AUA isoleucine	ACA threonine	AAA lysine	AGA arginine	A
	AUG methionine	ACG threonine	AAG lysine	AGG arginine	G
G	GUU valine	GCU alanine	GAU aspartate	GGU glycine	U
	GUC valine	GCC alanine	GAC aspartate	GGC glycine	C
	GUA valine	GCA alanine	GAA glutamate	GGA glycine	A
	GUG valine	GCG alanine	GAG glutamate	GGG glycine	G

* Note: AUG is an initiator codon and also codes for the amino acid methionine.

** Note: UAA, UAG, and UGA are terminator codons.

Information About Nitrogen Bases

Nitrogen Base	Classification	Abbreviation
Adenine	Purine	A
Guanine	Purine	G
Cytosine	Pyrimidine	C
Thymine	Pyrimidine	T
Uracil	Pyrimidine	U

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